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Engelmann Spruce Seedling Roots Reach Depth of 3 to 4 Inches Their First Season

Daniel L. Noble[1]

First-year Engelmann spruce seedlings have an average rooting depth of 3.4 inches, 11 branch roots, and a total root length of 5 inches. Seedlings were field-grown on scarified shaded seedbeds in the central Rocky Mountains, Colorado.

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The rate of root growth of Engelmann spruce seedlings (Picea engelmannii Parry) is important for survival, especially during the first growing season. Deeper root penetration will increase the probability of seedlings surviving drought, frost-heaving, and erosion.

Roe et al. (1970) reported rooting depth of only 1.5 inches for spruce seedlings in western Montana. Smith (1955) found that spruce seedlings grown under field conditions in British Columbia had short roots which averaged 1.7 inches in length with an average of 6.5 side roots. Jones (1971) listed vertical root penetration for Engelmann spruce seedlings of 2.7 inches in eastern Arizona.

None of the reports relate root growth to age, although seedlings were probably less than 3 months old. Consequently, those estimates of first-season root penetration may underestimate growth.

This study was conducted to provide estimates of: (1) rooting depth — main root in its unextended position following washing, (fig. 1); (2) number and length of unextended branch roots; and (3) total root length — rooting depth plus branch roots — for 3-month-old field-grown spruce seedlings in the central Rocky Mountains.

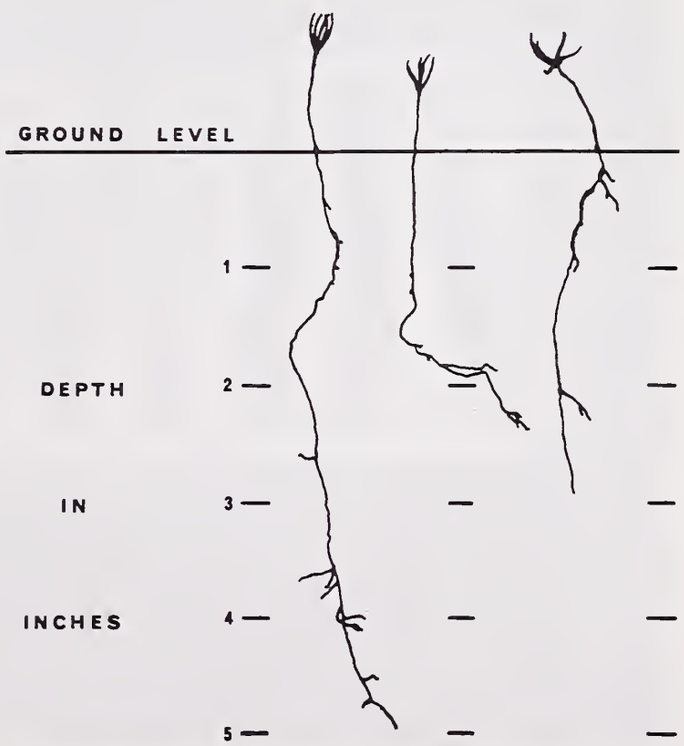

Figure 1.—Rooting depths of 3-month-old Engelmann spruce seedlings.

[1] *Forestry Research Technician, Rocky Mountain Forest and Range Experiment Station, with central headquarters maintained at Fort Collins, in cooperation with Colorado State University.*

Study Area Description

Seedlings were grown on the Fraser Experimental Forest, Colorado, in a 15-year-old spruce-fir clearcut on a gentle north-facing slope at an elevation of 10,600 feet. The dominant understory is whortleberry (Vaccinium myrtillus L. and V. scoparium Leiberg).

The climate of the area is typical of the subalpine zone of the west slope of the Front Range. Temperatures range from -30° to +90°F., and precipitation from 18 to 34 inches annually. A climatological summary of the experimental area has been provided by Haeffner (1971).

Temperatures and precipitation during the summer are important to this study. Average temperatures for an 8-year period (1965-72) were: maximum 63°F., minimum 38°F., and mean 50.5°F. Average precipitation was 7.6 inches with a range from 5.6 to 11.4 inches. Temperatures and precipitation are from the Fool Creek Windtower Station, approximately 300 yards from the study area, and with less than 100 feet difference in elevation.

The soil is a gravelly, sandy-loam Podzol of the Darling Series, developed in place under a spruce-fir stand from coarse-textured material weathered from mixed gneisses and schists (Retzer 1962). The average combined depth of A and B horizons is 12 to 16 inches. Laboratory analysis of the soil showed approximately 56, 34, and 10 percent sand, silt, and clay, respectively. Moisture contents at tensions of 1/3 and 15 bars were approximately 18 and 9 percent (Noble 1972).

Methods and Materials

Temperatures and precipitation were recorded on the study area during 3 summers (1970 through 1972) using a standard Weather Bureau shelter with a recording hygrothermograph and dial maximum-minimum thermometer. A standard 8-inch rain gage exposed without funnel or tube was weighed to measure precipitation.

Slash was removed and the area hand raked before further treatment. In late September of each year, 200 seeds (local seed source with 65 percent laboratory germination) were sown on the surface of two 1/4-mil-acre plots scarified to mineral soil and provided with about 50 percent overhead shade. The wooden shade frames were made from 1- by 2-inch fir strips held 8 inches above the ground by a 3/8-inch metal frame (fig. 2). Shade frame slats were oriented in a north-south direction so that throughout the day seedlings were alternately exposed to periods of shade and sunlight.

Seedlings that germinated in the last week of June or first week of July were measured

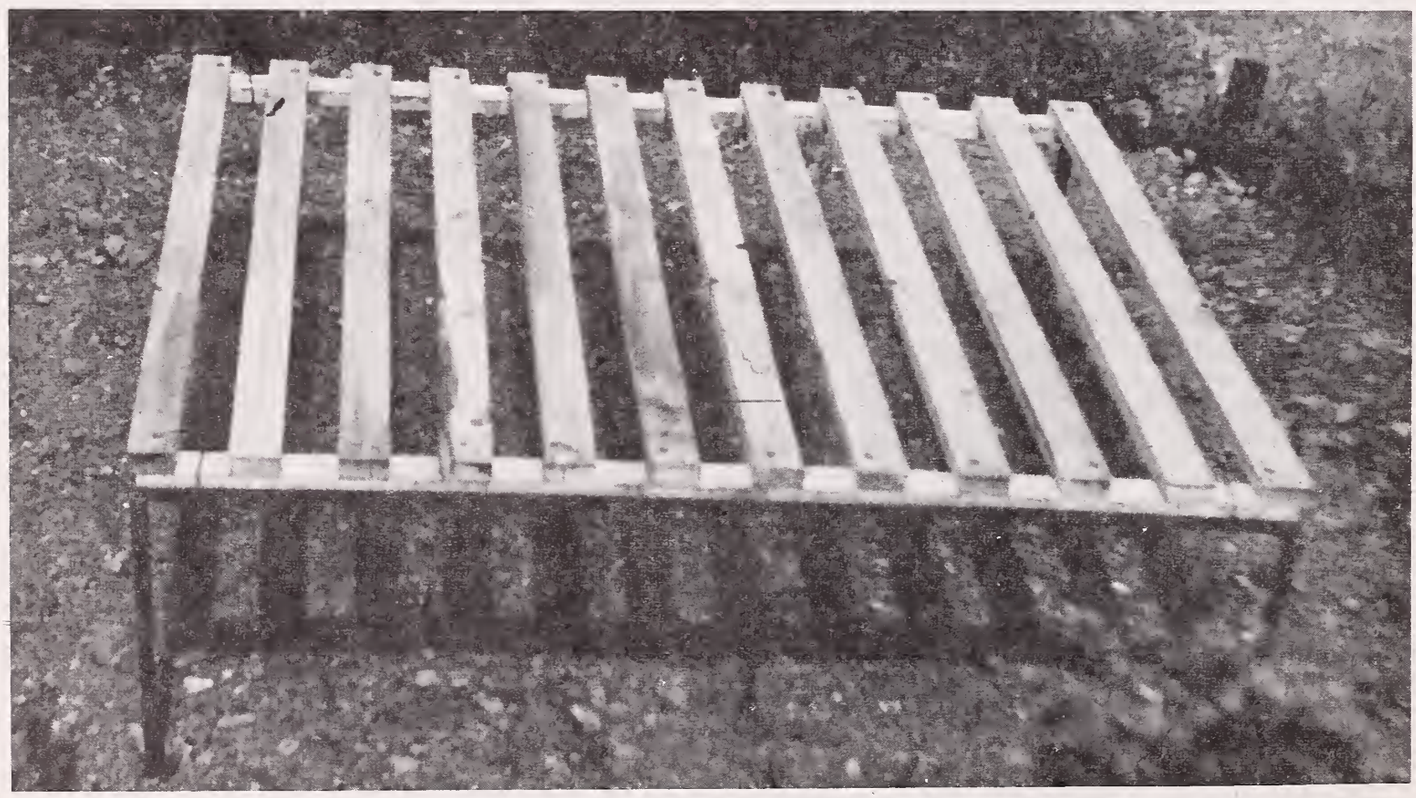

Figure 2.—Scarified and shaded seedbed.

when they reached 15 weeks (±1) of age. Seedlings were carefully lifted with a shovel and trowel, and the soil was washed from the roots in a water-filled barrel. Rooting depth and length of branch roots were measured to the nearest 0.1 inch.

Analysis of variance showed that differences in rooting depth, number of branch roots, and total root length between years were not significant. Therefore, the three samples (years) were combined to calculate means, ranges, and standard errors.

Results

Temperatures averaged close to normal with little difference between years. For the 3 growing seasons average temperatures were: maximum 63.1°F., minimum 38.6°F., and mean 50.9°F. Precipitation averaged about 1 inch below normal.

Fifteen seedlings survived to be measured in 1970, 16 in 1971, and 15 in 1972. The average root depth was 3.36 inches with a range from 2.0 to 5.3 inches, and the standard error for the mean was 0.10. Number of branch roots ranged from 2 to 37 and averaged 10.7, with a standard error of 1.02. Total root length averaged 4.98 inches, ranging from 2.4 to 9.0 inches. The standard error was 0.21.

Conclusions

Under field conditions, 15-week-old spruce seedlings do not develop a vigorous root system. Rooting depth is about 3.4 inches; branch roots are few in number, and range in length from 0.1 to 0.7 inch.

The failure of spruce to develop a deeper root system in the field is a major factor contributing to mortality on both mineral soil and undisturbed areas. Under severe drought conditions, first-summer root growth is not adequate to keep up with the rate at which the seedbed dries out. Furthermore, first-year seedlings are readily killed when weather conditions are conducive to frost-heaving.

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